Internship proposal 2017/2018

Topic: Optimizing video streaming quality of experience in home networks

Duration: 4 to 6 months

Hosting team: MiMove, Inria Paris (https://mimove.inria.fr/)
Joint team between Inria and Princeton University, HomeNet (https://team.inria.fr/homenet/)

Apply at: https://goo.gl/forms/CUYdaBmCA4iYaYpL2

Mentors:
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Keywords: Video Quality of Experience (QoE), Internet measurements, Home Networks, Network service optimization

Description:
Despite the steady increase in home broadband speeds, simple tasks like watching a video streamed over the Internet can still be a frustrating experience. Overloaded servers, network congestion, and poor home wifi quality are just a few of the potential root causes that can hamper the users Quality of Experience (QoE) [1]. Without the knowledge of where the problems might be located and in the hope of improving their experience, users often opt to pay higher fees to their residential Internet provider for increased access capacities. Yet, access link capacity is only one of the many potential bottlenecks impairing video quality. The key question to improve video QoE is: what is the root cause of video QoE impairments? Answering this question is challenging. No single entity (user, access ISP, content provider) has all the information to fully diagnose poor video QoE: the video application can track QoE impairments, but it cannot directly identify the root causes within the network; ISPs have more information about in network issues, but no direct knowledge of video QoE.

To identify the root causes of video QoE impairments, we have developed a novel lightweight system that runs at the home gateway. This vantage point is ideal for distinguishing issues within the user's home versus the access link [3]. Unfortunately, more and more content providers that rely on Dynamic Adaptive Streaming over HTTP (DASH) are transitioning to encrypted protocols (HTTPS/QUIC), which prevents our system from using deep-packet inspection to infer video QoE from video traffic traversing it [2]. To overcome this constraint, the system relies on DNS requests to identify video flows within network traffic and then tracks traffic patterns to infer key video QoE metrics such as average bitrate and re-buffering events. Moreover, the system exploits novel algorithms that use simple probing techniques, i.e. lightweight pings and traceroutes, to take advantage of the home network vantage point to pinpoint where potential root causes hampering the streaming process might be located. Once it identifies the root cause of poor video QoE, can our system bypass the problem to improve QoE?

The goal of this internship is to design and develop new optimization techniques to improve user QoE with focus on video streaming. The student will first learn the inner-workings of the existing system, which runs on a Raspeberry Pi. The student will analyze the data collected from our current deployment in 50+ homes in France and in the US to shed light on the most common root causes of video QoE. This analysis will also help she light on promising strategies to optimize video QoE. The data will include cross layer QoS and QoE information, from home wireless conditions to network traffic patterns and service QoS metrics (e.g. [5,6]), as well as user contextual information (e.g. [4]). After the design phase will be completed, the student will finally study how the new techniques could be integrated into the existing system.

During the internship, the student should develop scientific skills on network systems design and development and service optimization as well as scientific writing and presentation. If the student is interested, there is a possibility of staying for the doctoral studies after the internship.

Desirable skills:

- Comfortable communicating in English
- Comfortable with at least one scripting language (e.g. python)
- Knowledge of network protocols and network development tools
- Knowledge of matlab or gnu R

References

[1] Balachandran, Athula, et al. **A quest for an internet video quality-of-experience metric.** Proceedings of the 11th ACM workshop on hot topics in networks. ACM, 2012.

[2] Dimopoulos, Giorgos, et al. **Measuring Video QoE from Encrypted Traffic.** Proceedings of the 2016 ACM on Internet Measurement Conference. ACM, 2016.

[3] Sundaresan, Srikanth, Nick Feamster, and Renata Teixeira. **Home network or access link? locating last-mile downstream throughput bottlenecks.** International Conference on Passive and Active Network Measurement. Springer, Cham, 2016.

[4] J. Martin and N. Feamster. **User-driven dynamic traffic prioritization for home networks.** In Proc. of W-MUST, 2012.

[5] Chen, Junyang, et al. **Client-Driven Network-level QoE fairness for Encrypted 'DASH-S'.** Proceedings of the 2016 workshop on QoE-based Analysis and Management of Data Communication Networks. ACM, 2016.

[6] Bronzino, Francesco, et al. **Exploiting network awareness to enhance DASH over wireless.** Consumer Communications & Networking Conference (CCNC), 2016 13th IEEE Annual. IEEE, 2016.